



Short communication

Garlic and papaya lack control over gastrointestinal nematodes in goats and lambs

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ABSTRACT

Gastrointestinal nematodes (GIN) continue to hinder small ruminant production because of anthelmintic resistance and lack of effective products for GIN control in organic production. The objective of this study was to examine the effectiveness of a commercially available certified organic garlic product, fresh garlic juice, or garlic bulbs as an anthelmintic to control GIN in goats and papaya seeds for GIN control in lambs. In the first experiment, weaned meat goat kids were administered water or a commercial garlic juice product ($n = 7/\text{treatment}$). In the second experiment, kids were administered water, fresh garlic juice, or fed garlic bulbs ($n = 9$ or $10/\text{treatment}$). In a third experiment, lambs were administered nothing or papaya seed in water ($n = 12/\text{treatment}$). Naturally infected goats were supplemented with bermudagrass hay and corn/soybean supplement in the first experiment or maintained on bermudagrass pasture in the second experiment or lambs grazed mixed grasses in the third. Blood and fecal samples were collected on Days 0, 7, and 14 after administration of treatment to examine changes in blood packed cell volume (PCV) and fecal egg counts (FEC). PCV and FEC were similar by Day 14 between kids treated with a commercial garlic juice and water in the first experiment. Similarly, PCV was not different among treatment groups in the second experiment. FEC of the garlic juice group was lower than the other two groups on Day 0, but was similar among groups by Day 14. Deworming was required in one goat within each treatment group by Day 7 and in three kids in the garlic juice group and two in the garlic bulb group by Day 14. No changes in PCV or FEC were apparent in response to papaya seed compared with untreated lambs. Based on the alternative plant products used in this study, garlic or papaya seed is not recommended as an aid to control GIN in goats or lambs.

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1. Introduction

Haemonchus contortus, a blood-sucking parasite that thrives in warm, humid climates is considered the single most important pathogen in sheep (USDA, 2003). On a majority of sheep and goat farms in the southern U.S., eggs of *H. contortus* usually account for 75–100% of the total

fecal nematode egg output (Uhlinger et al., 1992; Mortensen et al., 2003). Organic producers of small ruminants lack an effective organic product for the control of gastrointestinal nematode (GIN) infection. The U.S. National Organic Program (2007) promotes use of ivermectin for salvage treatment of individuals, but any organic premium is lost as animals cannot be marketed as certified organic. Additionally, ivermectin resistance is prevalent in the U.S. goat population (Miller and Craig, 1996; Zajac and Gipson, 2000; Terrill et al., 2001; Mortensen et al., 2003). Of the alternative products for

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control of *H. contortus*, copper oxide wire particles have been effective in goats (Chartier et al., 2000; Burke et al., 2007), but are not approved for use in organic production or for parasite control. Herbal dewormers have failed to be effective against *H. contortus* (Burke et al., 2008; Luginbuhl et al., 2006). The use of garlic (*Allium sativum*) has been suggested (NCAT, 2004), but use in an herbal product against *H. contortus* was not effective (Burke et al., 2008; Luginbuhl et al., 2006). On-farm use of garlic juice may have been effective against GIN in lambs (http://www.garlicbarrier.com/2003_SARE_Report.html), but has not been examined under controlled conditions or with goats. Anthelmintic properties have been reported for latex and seeds from *Carica papaya* when used in humans and mice (Satrija et al., 1995; Okeniyi et al., 2007) and tested in vitro against *H. contortus* (Hounzangbe-Adote et al., 2005). Use of papaya against GIN in small ruminants has not been reported.

The objective of this study was to examine the effectiveness of a commercially available certified organic garlic product, fresh garlic juice, or garlic bulbs as an anthelmintic to control GIN in goats and papaya seeds for GIN control in lambs.

2. Materials and methods

2.1. Animals and procedures

The USDA, ARS Dale Bumpers Small Farms Research Station Institutional Animal Care and Use Committee (Booneville, AR) reviewed and approved all husbandry practices and experimental procedures used in this study.

In mid-May 2007, 14 Spanish or Spanish × Boer doe kids (14.3 ± 1.0 kg; ~112 days of age) weaned 30 days earlier and naturally infected with GIN were assigned randomly to be treated ($n = 7/\text{treatment}$) with 50 ml of water (control) or garlic juice (1:1 dilution of 99.3% formula Garlic Barrier, Garlic Research Labs, Inc., Glendale, CA). Treatments were administered as an oral drench per os to individual animals using a syringe. Kids were maintained in outside pens with scant forage growth of curly dock and other forbs and fed bermudagrass hay, 220 g corn/soybean meal (15% crude protein, dry matter basis; 78% corn, 18% soybean meal, 3.5% molasses, and 0.007% calcium carbonate), free choice trace mineral (Land O'Lakes Sheep and Goat Mineral, Shoreview, MN), and water.

In late May 2008, 29 Spanish doe kids (14.4 ± 0.7 kg; ~120 days of age) weaned 24 days earlier and naturally infected with GIN were assigned randomly to be treated with 40 ml of water (control) or garlic juice (freshly squeezed and stored at 1 °C for 20 h before use; $n = 10/\text{treatment}$) or three garlic bulbs (approximate equivalent of that used to extract juice) per kid. Water or juice was administered via stomach tube to individual animals. Kids fed bulbs grazed a separate pasture for 3 days or until all garlic had been consumed. Treatments were repeated 7 days later. Kids grazed bermudagrass pastures with free choice trace mineral (Land O'Lakes Sheep and Goat Mineral) and water. For both studies, individual goats were dewormed with 1 g copper oxide wire particles (Burke et al., 2007) if packed cell volume (PCV) was less than 19%.

A third experiment was conducted in August 2008. Approximately 150-day-old mixed gender Katahdin lambs weighing 25.8 ± 1.5 kg that had not been separated from dams were used. Lambs were assigned randomly to remain untreated or to be treated with 80 g papaya seed diluted to 110 ml with water ($n = 12/\text{group}$). Treatment was administered orally. Lambs were rotationally grazing mixed grass pastures alongside their dams.

For all studies, feces and blood were collected on Days 0, 7, and 14 after administration of treatments for fecal egg count (FEC) and blood PCV determination. FEC were performed using a modified McMaster's technique (Whitlock, 1948) with a sensitivity of 50 eggs/g of feces.

2.2. Statistical analysis

Data were analyzed using the mixed models procedure of SAS (1996). The mathematical model included treatment, breed (crossbred vs. straightbred Spanish; first experiment), gender (third experiment), day, treatment by day, and a repeated statement for day of measurement. Contrasts were determined using the PDIF option (all probability values for the hypothesis) in SAS when probability was less than 0.05%. FEC data were log transformed: $\ln(\text{FEC} + 1)$. In the second experiment, log transformed FEC from Day 0 were used as a covariate in the mixed model because FEC on that day were lower in one treatment group. Statistical inferences were made on transformed data and untransformed least squares means and standard errors were presented.

3. Results and discussion

In the first experiment, there tended to be a reduction in mean FEC 7 days post-garlic treatment compared with the control group, but FEC were similar on Day 14 (treatment by day, $P < 0.07$; Table 1). Administration of commercial garlic juice did not alter PCV, although there was a decline for both groups of kids between Days 0 and 14 ($P < 0.001$; Table 1). In addition, mean PCV of crossbred was less than that of Spanish kids ($24.8 < 30.7 \pm 1.3\%$; $P < 0.009$) but FEC were similar.

In the second experiment, FEC among all treatment groups was similar or increased between Days 0 and 14 ($P < 0.05$; Table 1). The FEC of the garlic juice group was lower than the other two groups on Day 0 and using Day 0 as a covariate, FEC means were similar among groups (Table 1). PCV was not different among treatments and declined between Days 0 and 14 ($P < 0.001$; Table 1). Deworming was required by Day 7 in one goat within each treatment group and by Day 14 in three kids in the garlic juice group and two in the garlic bulb group. In March 2008, dams were infected with 61% *H. contortus* and 39% *Trichostrongylus* (Burke and Miller, unpublished data) and percentage of *H. contortus* likely increased in these kids based on the need for deworming or low PCV in 27% of kids by Day 21.

Garlic may (Salman et al., 1999; Colic and Savic, 2000) or may not (Yang et al., 2007) stimulate the immune system of an animal. If garlic were to stimulate the immune system of goats, long-term exposure to garlic may

Table 1

Least squares means and standard errors (S.E.) of fecal egg counts (FEC; eggs/g) and blood packed cell volume (PCV; %) for goats treated with water (control) or garlic juice (garlic barrier; Experiment 1; $n = 7$ /treatment), water, fresh garlic juice, or garlic bulbs (Experiment 2; $n = 10$ /treatment), or lambs treated with nothing or papaya seeds (Experiment 3; $n = 12$ /treatment). Statistical analysis of FEC was performed on log transformed values and untransformed means are presented.

Treatment	Measurement	Day of experiment			
		0	7	14	S.E.
Experiment 1					
Control	FEC	578	2921	1807	393
	PCV	29.0	26.4	25.8	1.3
Garlic	FEC	857	992	1471	393
	PCV	30.4	28.4	26.4	1.3
Experiment 2					
Control	FEC	4177	2850	4539	803
	PCV	24.0	23.3	20.3	1.3
Garlic juice	FEC	2509	2840	3705	762
	PCV	26.4	24.9	21.7	1.2
Garlic bulbs	FEC	5230	3650	5970	801
	PCV	24.6	23.7	20.8	1.2
Experiment 3					
Control	FEC	2193	2871	4271	697
	PCV	30.1	29.9	24.4	1.4
Papaya	FEC	3545	4540	5657	716
	PCV	26.8	28.1	23.4	1.5

lead to a lower susceptibility to GIN. This would not be practical using the liquid form, but a powdered form could be added to a feed supplement or mineral product. However, Wang et al. (2008) reported no changes in immune function or FEC in goats fed garlic powder.

Fresh garlic juice was used in the second experiment because the manufacturing process can influence the composition or bioactive compounds of the garlic product (Amagase et al., 2001). However, neither garlic juice product led to decreased FEC by Day 14. The lower FEC on Day 7 in the group treated with the commercial garlic product may warrant further research on repeated use. Garlic bulbs were offered to one group of goats in the second experiment as a convenient means of providing fresh garlic. Not all bulbs were consumed and some individuals may have consumed more than others. There was 1 of 10 goats that exhibited a reduction in FEC between Days 0 and 14 (16,750–2050 eggs/g) and PCV increased slightly (20–22%). The FEC in the remaining goats in this group increased and PCV decreased during this time period.

In the third experiment, there was no indication that administration of papaya seed led to a reduction in GIN in lambs. Between Days 0 and 14, FEC increased in both groups ($P < 0.001$) and PCV decreased during this time ($P < 0.001$; Table 1). Predominant GIN were likely *H. contortus* because a majority of these lambs required deworming due to anemia 30 days after this study ended. Papaya latex secreted from the skin of an injured papaya is rich in proteolytic enzymes believed to digest the cuticle of adult nematodes (Steppek et al., 2004). In the previous studies, papaya latex was effective against intestinal worms (*Heligmosomoides poly-*

gyrus) in mice (Satrija et al., 1995), but not stomach worms (*Protoparva muricola*) unless stomach acid was neutralized (Steppek et al., 2007). Worm counts of *Hymenolepis nana* in mice decreased in response to 1.2 g/kg papaya seed for three consecutive days (Lamtiur, 2000). Little is reported on in vivo response of papaya seed on *H. contortus*. Under the conditions of this study, administration of papaya seed was not effective against GIN in lambs.

Alternative means of acute control of GIN are still in demand where *H. contortus* predominates. Based on the alternative products used in this study, garlic is not recommended as an acute control for GIN in goats or papaya in lambs.

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Mention of trade names or commercial products in this manuscript is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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